

1 RECOMMENDATIONS FOR STANDARDS

The National Institute for Occupational Safety and Health (NIOSH) recommends that worker exposure to ethylene glycol monobutyl ether (EGBE) and ethylene glycol monobutyl ether acetate (EGBEA) be controlled in the workplace by complying with the provisions presented in Chapter 1 of this document. These recommendations are designed to protect the health and provide for the safety of workers for up to a 10-hr workshift and a 40-hr workweek over a working lifetime. Adherence to these recommendations should prevent or greatly reduce the risk of adverse effects on exposed workers.

Because environmental concentrations of contaminants vary from day to day, a time-weighted average (TWA) exposure that is below the NIOSH recommended exposure limit (REL) on a given day does not necessarily indicate that exposure on other days will also be below the REL. If a worker's TWA exposure during a workshift is one-half or more of the REL, it is probable that exposures will exceed the REL on other days. Therefore an "action level"* of one-half the REL should be adopted to ensure adequate protection of workers.

SECTION 1.1 RECOMMENDED EXPOSURE LIMITS FOR EGBE AND EGBEA

1.1.1 Exposure

Exposure to EGBE and EGBEA in the workplace shall be controlled so that workers are not exposed to concentrations greater than 5 parts per million parts of air (5 ppm) (24 mg EGBE/m³ or 33 mg EGBEA/m³).

Dermal contact shall be prohibited because EGBE and EGBEA are readily absorbed through the skin.

1.1.2 Sampling and Analysis

Workplace air samples shall be collected and analyzed for EGBE as described in the *NIOSH Manual of Analytical Methods*, Method No. 1403 [NIOSH 1984] (see Appendix A); this method may be adapted for EGBEA as well. OSHA Method No. 83 [OSHA 1990] is also recommended for sampling and analysis of EGBE and EGBEA.

*In this recommended standard for EGBE and EGBEA, the "action level" is the concentration at which exposure monitoring and medical monitoring should be initiated.

SECTION 1.2 EXPOSURE MONITORING

Exposure monitoring shall be conducted as specified in Sections 1.2.1, 1.2.2, and 1.2.3. Results of all exposure monitoring shall be recorded and maintained as specified in Section 1.9.

1.2.1 Industrial Hygiene Surveys

In work areas where airborne exposures to EGBE or EGBEA may occur, the employer shall conduct initial industrial hygiene surveys to determine their magnitude by using personal sampling techniques for an entire workshift. The employer shall keep records of these surveys. If the employer concludes that exposures to EGBE and EGBEA are below the REL, the records must show the basis for this conclusion. Surveys shall be repeated at least annually and whenever any process change is likely to increase concentrations of airborne EGBE and EGBEA. The employer shall also look for, evaluate, and record the potential for skin exposure.

1.2.2 Personal Monitoring

If workers are exposed to EGBE or EGBEA at or above the action level (one-half the REL), a program of personal monitoring shall be instituted to identify and measure or calculate the exposure of each worker occupationally exposed to airborne EGBE and EGBEA (see Section 8.8). Source and area monitoring may be a useful supplement to personal monitoring. In all personal monitoring, samples representative of the TWA exposures to airborne EGBE and EGBEA shall be collected in the breathing zone of the worker. Procedures for sampling and analysis shall be in accordance with Section 1.1.2. For each determination of an occupational exposure concentration, a sufficient number of samples shall be collected to characterize each worker's exposure during each workshift (see Section 8.8). Although not all workers must be monitored, sufficient samples must be collected to characterize the exposure of all workers. Variations in work and production schedules as well as worker locations and job functions shall be considered when deciding about sampling locations, times, and frequencies.

If a worker is found to be exposed to EGBE or EGBEA below the REL but at or above the action level, the exposure of that worker shall be monitored at least once every 6 months or as otherwise indicated by a professional industrial hygienist. If a worker is found to be exposed to EGBE or EGBEA above the REL, the worker must wear a respirator for protection until adequate engineering controls or work practices are instituted. Controls shall then be initiated, the worker shall be notified of the exposure and of the control measures being implemented, and the worker's exposure shall be evaluated at least once a week. Such monitoring shall continue until two consecutive determinations at least 1 week apart indicate that the worker's exposure no longer exceeds the REL. At that time, semiannual monitoring shall be instituted; if concentrations of EGBE and EGBEA below the action level are noted after two semiannual consecutive surveys, sampling can be conducted annually.

1.2.3 Biological Monitoring

Measurement of urinary butoxyacetic acid (BAA), the metabolite of EGBE and EGBEA, may help characterize occupational EGBE and EGBEA exposures when the potential exists for airborne concentrations at the REL, or for skin contact from accidental exposure or breakdown of chemical protective clothing (see Section 8.6.1). Guidelines for biological monitoring are presented in Appendix D.

SECTION 1.3 MEDICAL MONITORING

The employer shall provide the following information to the physician who performs or is responsible for the medical monitoring program:

- The requirements of the applicable standard
- An estimate of the worker's potential exposure to EGBE or EGBEA, including any available workplace sampling results
- A description of the worker's duties as they relate to exposure
- A description of any protective equipment the worker may be required to use

1.3.1 General

- The employer shall institute a medical monitoring program for all workers who are exposed to airborne concentrations of EGBE or EGBEA at or above the action level, or who have the potential for skin exposure.
- The employer shall ensure that all medical examinations and procedures are performed by or under the direction of a licensed physician.
- The employer shall provide the required medical monitoring without loss of pay or other cost to the workers, and at a reasonable time and place.

1.3.2 Preplacement Medical Examinations

Preplacement medical examinations shall include at least the following:

- A comprehensive medical and work history that emphasizes identification of existing medical conditions (e.g., those affecting the blood, hematopoietic and central nervous systems, skin, liver, and kidneys) and previous occupational exposure to chemical or physical agents
- A medical examination giving special attention to the blood, hematopoietic and central nervous systems, skin, liver, and kidneys

- A judgment about the worker's ability to use positive- and negative-pressure respirators

1.3.3 Periodic Medical Examinations

Periodic medical examinations shall be provided at least annually to all workers occupationally exposed to airborne concentrations of EGBE or EGBEA at or above the action level, and to workers with the potential for skin exposure. These examinations shall include at least the following:

- An update of medical and work histories
- A medical examination and tests giving special attention to the hematopoietic and central nervous systems, blood, skin, liver, and kidneys
- Urinary monitoring, which may serve as a useful adjunct to environmental monitoring because it indicates both airborne and dermal exposures (see Section 1.2.3)

SECTION 1.4 LABELING AND POSTING

All labels and warning signs shall be printed both in English and the predominant language of workers who do not read English. Workers unable to read the labels and warning signs shall be informed verbally regarding the instructions printed on labels and signs in the hazardous work areas of the plant.

1.4.1 Labeling

Containers of EGBE or EGBEA used or stored in the workplace shall carry a permanently attached label that is readily visible. The label shall identify the glycol ether and give information regarding its effects on human health and emergency procedures (see Figure 1-1).

1.4.2 Posting

Signs bearing information about the health effects of EGBE and EGBEA shall be posted in readily visible positions in work areas and at entrances to work areas or building enclosures where exposures may exceed the REL and where skin exposures may occur (see Figure 1-2).

If respirators and personal protective clothing are needed when there is the possibility of skin exposure and airborne exposure at or above the REL during the manufacturing or handling of these glycol ethers or during the installation or implementation of required engineering controls, the following statement shall be added in large letters to the signs required in this section:

Respiratory Protection And Protective Clothing Required In This Area

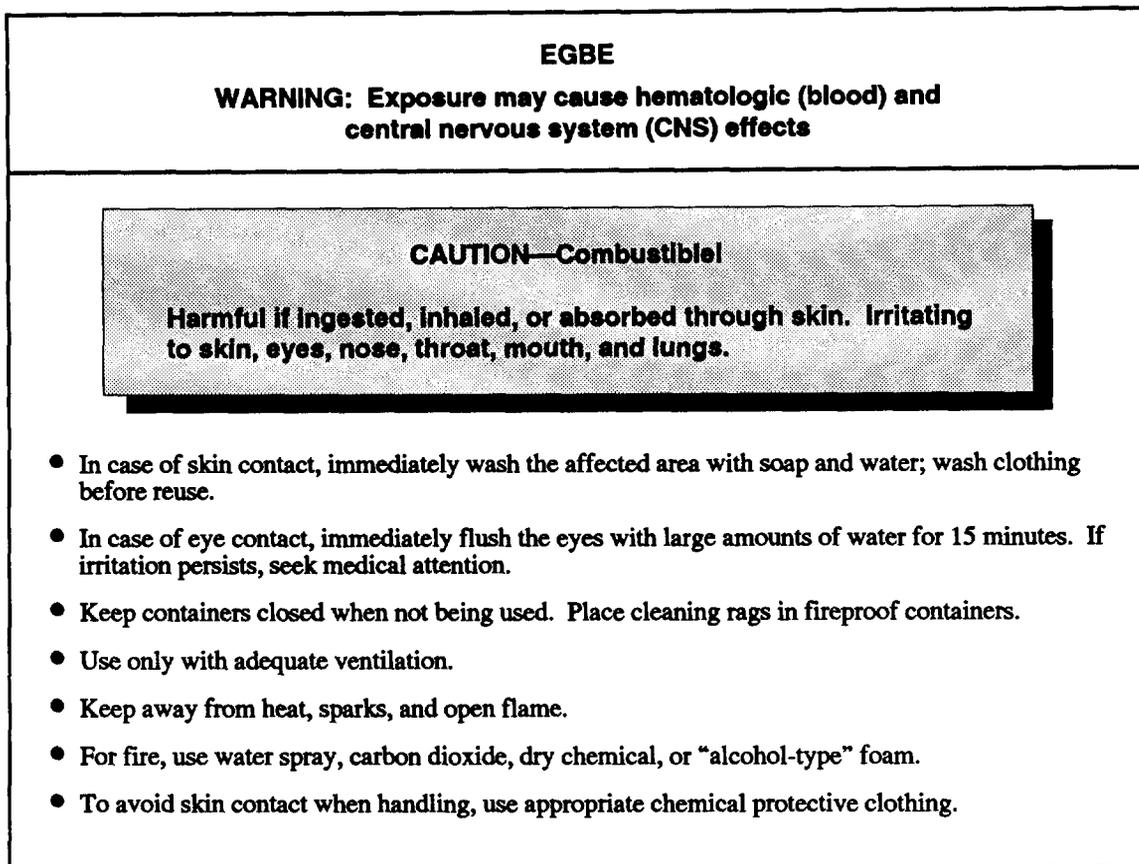


Figure 1-1. Example of a container label identifying the glycol ether and listing information about its effects on human health and emergency procedures.

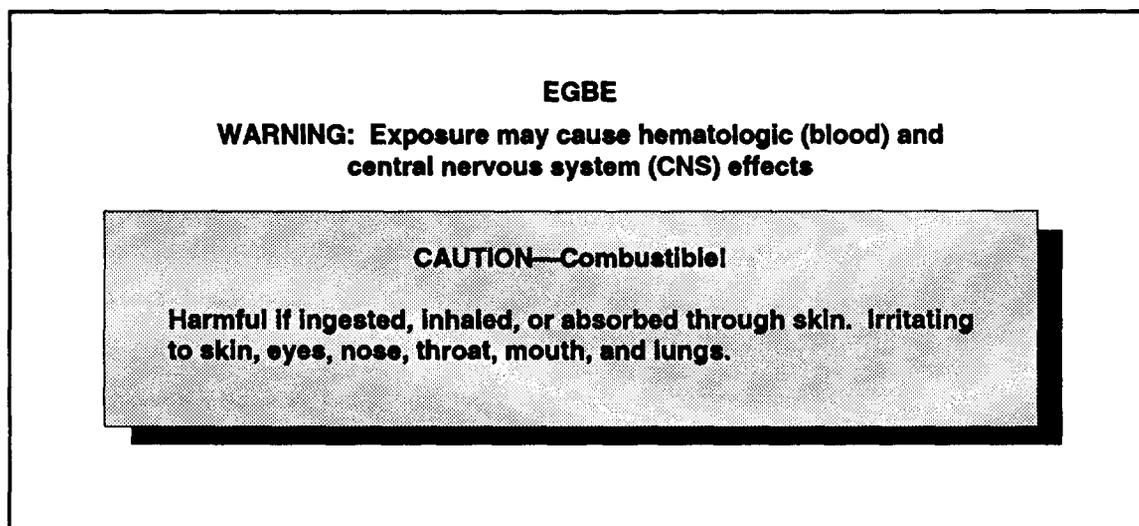


Figure 1-2. Example of a sign containing information about the health effects of EGBE .

In any area where emergency situations may arise, the required signs shall be supplemented with emergency first-aid procedures and the locations of emergency showers and eyewash fountains.

SECTION 1.5 PROTECTIVE CLOTHING AND EQUIPMENT

Engineering controls and good work practices shall be used to keep the airborne concentrations of EGBE and EGBEA below the REL and to prevent skin and eye contact. When protective clothing and equipment are needed, they shall be provided by the employer.

1.5.1 Eye and Face Protection

The employer shall provide chemical splash-proof safety goggles or face shields (20-cm minimum) with goggles and shall ensure that workers wear the protective equipment during any operation in which splashes of EGBE or EGBEA are likely to occur. Devices for eye and face protection shall be selected, used, and maintained in accordance with 29 CFR* 1910.133 and 30 CFR 56.150004 and 57.150004.

1.5.2 Skin Protection

- Workers at risk of skin exposure to EGBE or EGBEA shall be provided with appropriate protective clothing such as gloves and disposable clothing. Information presented in Section 8.6.1 provides guidance in the selection of appropriate materials for gloves and clothing.
- Clothing contaminated with EGBE or EGBEA shall be cleaned before reuse. Anyone who handles contaminated clothing or is responsible for its cleaning shall be informed about the hazards of these glycol ethers and the proper precautions for their safe handling and use.
- The employer shall ensure that all personal protective clothing and equipment is inspected regularly and maintained in a clean and satisfactory working condition.

1.5.3 Respiratory Protection

- Engineering controls and good work practices shall be used to control respiratory exposure to airborne contaminants. The use of respirators is the least desirable method of controlling worker exposures and should not be used as the primary control method during routine operations. However, NIOSH recognizes that respirators may be required to provide protection in certain situations such as implementation of engineering controls, short-duration maintenance procedures, and emergencies. Respirator selection guides for protection against EGBE and EGBEA are presented in Tables 1-1 and 1-2, respectively.

**Code of Federal Regulations.* See CFR in references.

Table 1-1.—NIOSH recommended respiratory protection for EGBE

Condition	Minimum respiratory protection *
50 ppm or less [10 × REL]	Any air-purifying respirator equipped with organic vapor cartridges, [†] or Any supplied-air respirator equipped with a half-mask [†]
125 ppm or less [25 × REL]	Any powered, air-purifying respirator equipped with a loose-fitting hood or helmet and an organic vapor cartridge or canister, or Any supplied-air respirator operated in a continuous-flow mode [†]
250 ppm or less [50 × REL]	Any air-purifying, full-facepiece respirator equipped with organic vapor cartridges or canister, or Any supplied-air respirator with a full facepiece, or Any self-contained breathing apparatus with a full facepiece, or Any powered, air-purifying respirator equipped with a tight-fitting facepiece and organic vapor cartridges or canister
700 ppm or less	Any supplied-air respirator equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode
Greater than 700 ppm	Any self-contained breathing apparatus equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode
Fire fighting	Any self-contained breathing apparatus equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode
Escape	Any air-purifying, full-facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister, or Any appropriate escape-type, self-contained breathing apparatus

* Only NIOSH- or MSHA-approved equipment shall be used.

[†] If eye irritation occurs, a respirator equipped with full facepiece, helmet, or hood shall be used.

Table 1-2.—NIOSH recommended respiratory protection for EGBEA

Condition	Minimum respiratory protection*
50 ppm or less [10 × REL]	Any air-purifying respirator equipped with a half-mask [†]
125 ppm or less [25 × REL]	Any powered, air-purifying respirator equipped with an organic vapor cartridge or canister, [†] or Any supplied-air respirator equipped with a hood or helmet and operated in a continuous-flow mode
250 ppm or less [50 × REL]	Any supplied-air respirator with a full facepiece, or Any self-contained breathing apparatus with a full facepiece, or Any powered, air-purifying respirator equipped with a tight-fitting facepiece and organic vapor cartridges or canister
700 ppm or less	Any supplied-air respirator equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode
Greater than 700 ppm	Any self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode
Fire fighting	Any self-contained breathing apparatus equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode
Escape	Any air-purifying, full-facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister, or Any appropriate escape-type, self-contained breathing apparatus

*Only NIOSH- or MSHA-approved equipment shall be used.

[†]If eye irritation occurs, a respirator equipped with full facepiece, helmet, or hood shall be used.

- Respirators shall be provided by the employer when such equipment is necessary to protect the health of the worker. The worker shall use the provided respiratory protection in accordance with instructions and training received.
- The employer shall ensure that respirators are properly fitted and that workers are instructed at least annually in the proper use and testing for leakage of respirators assigned to them.
- Workers should not be assigned to tasks requiring the use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. The medical status of the respirator user should be reviewed at least annually or as recommended by the physician responsible for the physical examination. See Appendix E for additional information on the medical aspects of wearing respirators.
- The employer shall be responsible for establishing and maintaining a respiratory protection program as summarized below:
 1. Written standard operating procedures governing selection and use of respirators shall be established.
 2. The worker shall be instructed and trained in the proper use of respirators and their limitations.
 3. Where practicable, the respirators should be assigned to individual workers for their exclusive use.
 4. Respirators shall be regularly cleaned and disinfected.
 5. Respirators shall be stored in a convenient, clean, and sanitary location.
 6. Respirators used routinely shall be inspected during cleaning. Worn or deteriorated parts shall be replaced. Respirators for emergency use (e.g., self-contained devices) shall be thoroughly inspected at least once a month and after each use.
 7. The respiratory protection program shall be regularly evaluated by the employer to determine its continued effectiveness.
 8. Additional information on the selection, maintenance, and use of respirators can be found in the *NIOSH Respirator Decision Logic* [NIOSH 1987b] and the *NIOSH Guide to Industrial Respiratory Protection* [NIOSH 1987a].

*The minimum requirements for a respiratory protection program for general industry established by the Occupational Safety and Health Administration (OSHA) may be found in 29 CFR 1910.134 and the minimum requirements for the mining industry established by the Mine Safety and Health Administration (MSHA) may be found in 30 CFR 56.5005, 57.5005, 70.305, and 70.305-1.

SECTION 1.6 INFORMING WORKERS ABOUT THE HAZARDS OF EGBE AND EGBEA

1.6.1 Hazard Communication

All workers who are assigned to areas where airborne exposures to EGBE or EGBEA are at or above the action level or who have the potential for skin exposure shall be kept informed of the hazards, relevant signs and symptoms of toxicity, and proper conditions and precautions for the safe use and handling of EGBE and EGBEA. Workers shall be made aware of possible central nervous system (CNS) and hematologic effects of exposure to EGBE and EGBEA.

1.6.2 Training

The employer shall institute a continuing education program conducted by persons qualified by experience or training in occupational safety and health. The program shall ensure that all workers exposed to EGBE or EGBEA have current knowledge of glycol ether hazards, proper maintenance, cleanup methods, and proper use of protective clothing and equipment, including respirators. The instructional program shall include oral and written descriptions of the environmental and medical monitoring programs and of the advantages of worker participation in these surveillance programs. The employer shall maintain a written plan of these training and surveillance programs. In addition, employers shall follow the OSHA regulations in 29 CFR 1910.1200, Hazard Communication.

Workers shall also be instructed about their responsibilities for following proper work practices and sanitation procedures to help protect their health and provide for their safety and that of their fellow workers.

All workers in areas where EGBE or EGBEA exposures may occur during spills or emergencies shall be trained in proper emergency and evacuation procedures.

1.6.3 File of Written Hazard Information

Required information shall be recorded on the material safety data sheet (MSDS) shown in Appendix B, or on a similar OSHA form that describes the relevant toxic, physical, and chemical properties of the glycol ethers and mixtures of glycol ethers that are used or otherwise handled in the workplace. This information shall be kept on file and shall be readily available to workers for examination and copying.

SECTION 1.7 ENGINEERING CONTROLS AND WORK PRACTICES

1.7.1 Engineering Controls

Engineering controls shall be used when needed to maintain exposure to airborne EGBE or EGBEA within the limits prescribed in Section 1.1.

1.7.1.1 Local Exhaust Ventilation

Local exhaust ventilation may be effective when used alone or in combination with process enclosure. When a local exhaust ventilation system is used, it shall be designed and operated to prevent accumulation or recirculation of airborne EGBE or EGBEA in the workplace. Exhaust ventilation systems discharging to outside air shall conform with applicable local, State, and Federal air pollution regulations and shall not constitute a hazard to workers or to the general population. Before maintenance work on control equipment begins, the generation of airborne EGBE or EGBEA shall be eliminated to the greatest extent feasible.

1.7.1.2 Maintaining Design Airflow

Enclosures, exhaust hoods, and ductwork shall be kept in good repair to maintain designed airflows. Measurements such as capture velocity, duct velocity, or static pressure shall be made at least semiannually, and preferably monthly, to demonstrate the effectiveness (quantitatively, the ability of the control system to maintain exposures below the REL) of the mechanical ventilation system. NIOSH recommends the use of continuous airflow indicators such as water or oil manometers marked to indicate acceptable airflow. A record shall be kept showing design airflow and the results of all airflow measurements. Measurements of the effectiveness of the system in controlling exposures shall also be made as soon as possible after any change in production, process, or control devices that may increase airborne concentrations of EGBE or EGBEA.

1.7.1.3 Forced-Draft Ventilation

Forced-draft ventilation systems shall be equipped with remote manual controls and should be designed to shut off automatically in the event of a fire.

1.7.2 General Work Practices

- Operating instructions for all equipment shall be developed and posted where EGBE and EGBEA are handled or used.
- Transportation and use of EGBE and EGBEA shall comply with all applicable local, State, and Federal regulations.
- EGBE and EGBEA shall be stored in tightly closed containers and in well ventilated areas.
- Containers shall be moved only with the proper equipment and shall be secured to prevent loss of control or dropping during transport.
- Storage facilities shall be designed to prevent contamination of workroom air and to contain spills completely within surrounding dikes.
- Ventilation switches and emergency respiratory equipment shall be located outside storage areas in readily accessible locations.

- Process valves and pumps shall be readily accessible and shall not be located in pits or congested areas.
- EGBE and EGBEA containers and systems shall be handled and opened with care. Approved protective clothing and equipment as specified in Section 1.5 shall be worn by workers who open, connect, and disconnect EGBE and EGBEA containers and systems. Adequate ventilation shall be provided to minimize exposures of such workers to airborne EGBE or EGBEA.
- EGBE and EGBEA storage equipment and systems shall be inspected daily for signs of leakage. All equipment, including valves, fittings, and connections, shall be checked for leaks immediately after EGBE and EGBEA are introduced therein.
- When a leak is found, it shall be repaired promptly. Work shall resume normally only after necessary repair or replacement has been completed and the area has been well ventilated.

1.7.3 Confined or Enclosed Spaces

- A permit system shall be used to control entry into confined or enclosed spaces such as tanks, pits, tank cars, and process vessels where egress is limited. Permits shall be signed by an authorized representative of the employer and shall certify that preparation of the confined space, precautionary measures, and personal protective equipment are adequate and that precautions have been taken to ensure that prescribed procedures will be followed.
- Confined spaces that hold containers of EGBE or EGBEA shall be thoroughly ventilated, inspected, and tested for oxygen deficiency and for airborne concentrations of these compounds. Every effort shall be made to prevent the inadvertent release of hazardous amounts of EGBE or EGBEA into confined spaces where work is in progress. EGBE or EGBEA supply lines shall be disconnected or blocked off before such work begins.
- No worker shall enter a confined space without an entry large enough to admit a worker wearing safety harness, lifeline, and appropriate personal protective equipment as specified in Section 1.5.
- Confined spaces shall be ventilated while work is in progress to keep the concentration of EGBE and EGBEA below the REL, to keep the concentration of other contaminants below toxic or dangerous levels, and to prevent oxygen deficiency.
- If the concentration of EGBE or EGBEA in the confined space exceeds the REL, respiratory protective equipment is required for entry.
- Anyone entering a confined space shall be observed from the outside by another properly trained and protected worker. An additional supplied-air or self-contained breathing apparatus with safety harness and lifeline shall be located outside

the confined space for emergency use. The person entering the confined space shall maintain continuous communication with the standby worker.

1.7.4 Emergency Procedures

Emergency plans and procedures shall be developed for all work areas where there is a potential for exposure to EGBE or EGBEA. These plans and procedures shall include those specified below and any others considered appropriate for a specific operation or process. Workers shall be instructed in the effective implementation of these plans and procedures.

- The following steps shall be taken in the event of a leak or spill of EGBE or EGBEA:
 - All nonessential personnel shall be evacuated from the leak or spill area.
 - Persons not wearing the appropriate protective equipment and clothing shall be restricted from the leak or spill area until cleanup has been completed.
 - All ignition sources shall be removed.
 - The area where the leak or spill occurs shall be adequately ventilated to prevent the accumulation of vapor.
 - The EGBE and EGBEA shall be contained and absorbed with vermiculite, sand, or paper towels.
 - Small quantities of absorbed material shall be placed under a fume hood and sufficient time shall be allowed for the liquid to evaporate and for the vapors to clear the ductwork in the hood.
 - Large quantities of absorbed material shall be pyrolyzed in a suitable combustion chamber.
 - Contaminated absorbent materials shall be disposed of as hazardous waste.
 - The spill area shall be cleaned with water.
- Only personnel trained in the emergency procedures and protected against the attendant glycol ether hazards shall clean up spills and control and repair leaks.
- Personnel entering the spill or leak area shall be furnished with appropriate personal protective clothing and equipment. Other personnel shall be prohibited from entering the area.
- Safety showers, eyewash fountains, and washroom facilities shall be provided, maintained in working condition, and made readily accessible to workers in all areas where skin or eye contact with EGBE or EGBEA is likely. If EGBE or

EGBEA is splashed or spilled on a worker, contaminated clothing shall be removed promptly, and the skin shall be washed thoroughly with soap and water. Eyes splashed by EGBE or EGBEA shall be irrigated immediately with a copious flow of water for 15 min. If irritation persists, the worker should seek medical attention.

1.7.5 Storage

EGBE and EGBEA shall be stored in cool, well-ventilated areas and kept away from acids, bases, and oxidizing agents.

1.7.6 Waste Disposal

All waste material shall be securely packaged in double bags, labeled, and incinerated. The incinerator residue shall be disposed of in a manner consistent with Federal (U.S. Environmental Protection Agency), State, and local regulations, or it shall be disposed of in a licensed hazardous waste landfill.

SECTION 1.8 SANITATION AND HYGIENE

1.8.1 Food, Cosmetics, and Tobacco

The following shall be prohibited in areas where EGBE or EGBEA is produced or used: the storage, preparation, dispensing, or consumption of food or beverages; the storage or application of cosmetics; and the storage or use of all tobacco products.

1.8.2 Handwashing

The employer shall provide handwashing facilities and encourage workers to use them before eating, smoking, using the toilet, or leaving the worksite.

1.8.3 Laundering

- Protective clothing, equipment, and tools shall be cleaned periodically.
- The employer shall provide for the cleaning, laundering, or disposal of contaminated work clothing and equipment.
- Any person who cleans or launders this work clothing or equipment must be informed by the employer that it may be contaminated with EGBE or EGBEA—chemicals that may cause adverse hematologic (blood) and CNS effects.

1.8.4 Cleanup of Work Area

The work area shall be cleaned at the end of each shift (or more frequently if needed) using vacuum pickup. Collected wastes shall be placed in sealed containers with labels that

indicate the contents. Cleanup and disposal shall be conducted in a manner that prevents worker contact with wastes and complies with all applicable local, State, and Federal regulations.

1.8.5 Showering and Changing Facilities

Workers shall be provided with facilities for showering and changing clothes at the end of each workshift.

SECTION 1.9 RECORDKEEPING

1.9.1 Exposure Monitoring

The employer shall establish and maintain an accurate record of all exposure measurements required in Section 1.8 of this document. These records shall include the name of the worker being monitored, social security number, duties performed and job locations, dates and times of measurements, sampling and analytical methods used, type of personal protection used (if any), and number, duration, and results of samples taken.

1.9.2 Medical Monitoring

The employer shall establish and maintain an accurate record for each worker subject to the medical monitoring specified in Section 1.3 of this document. Pertinent medical records (i.e., the physician's written statement, the results of medical examinations and tests, medical complaints, etc.) shall be retained in the medical files of all workers subject to airborne concentrations of EGBE or EGBEA in the workplace at or above the action level. Copies of applicable environmental monitoring data shall also be included in the worker's medical file.

1.9.3 Record Retention

In accordance with the requirements of 29 CFR 1910.20(d), Preservation of Records, the employer shall retain the records described in Sections 1.2 and 1.3 of this document for at least the following periods:

- 30 years for exposure monitoring records, and
- Duration of employment plus 30 years for medical surveillance records

1.9.4 Availability of Records

In accordance with 29 CFR 1910.20, Access to Employee Exposure and Medical Records, the employer shall, upon request, allow examination and copying of exposure monitoring records by the subject worker, the former worker, or anyone having the specific written consent of the subject or former worker.

Any medical records required by this recommended standard shall be provided upon request, for examination and copying, to the subject worker, the former worker, or anyone having the specific written consent of the subject or former worker.

1.9.5 Transfer of Records

The employer shall comply with the requirements for the transfer of records as set forth in 29 CFR 1910.20(h), Transfer of Records.

2 INTRODUCTION

2.1 PURPOSE

This document presents the criteria and recommended standards necessary to prevent health impairment from exposure to EGBE and EGBEA—two solvents used primarily in surface coatings. The principal signs and symptoms of acute overexposure to these compounds are irritation of the eyes, nose, and throat; drowsiness; nausea; shaking; and weakness. Repeated exposure may damage the bone marrow, blood cells, kidneys, and liver. The document was developed in response to Section 20(a)(3) of the Occupational Safety and Health (OSH) Act of 1970 [29 USC 1900 (1970)]. In this act, NIOSH is charged with developing criteria for toxic materials and harmful physical agents to describe exposure concentrations at which no worker will suffer impaired health or functional capacities or diminished life expectancy as a result of work experience. This document also responds to Section 2.2(c)(1) of the OSH Act, which authorizes the National Institute for Occupational Safety and Health (NIOSH) to develop and establish recommended occupational safety and health standards.

NIOSH has formalized a system for developing criteria on which to base standards for ensuring the health and safety of workers exposed to hazardous chemical and physical agents. Simple compliance with these standards is not the only goal. The criteria and recommended standards are intended to help management and labor develop better engineering controls and more healthful work practices.

Recommended standards for EGBE and EGBEA apply only to workplace exposures arising from the processing, manufacturing, handling, and use of EGBE and EGBEA. The recommendations are not designed for the population at large, and any extrapolation beyond the occupational environment may not be warranted. The recommended standards are intended to protect workers from the acute and chronic effects of EGBE and EGBEA. Exposure concentrations are measurable by techniques that are valid, reproducible, and available to industry and government agencies.

2.2 SCOPE

The information in this document assesses the hazards associated with occupational exposure to EGBE and EGBEA. Chapter 1 presents the recommended standard and describes its requirements. Chapter 3 gives information about the chemical and physical properties of EGBE and EGBEA, production methods, uses, and the extent of worker exposure. Chapter 4 discusses and summarizes the effects of exposure to these glycol ethers on humans and animals. Subsequent chapters describe environmental sampling and analytical methods,

EGBE and EGBEA

medical monitoring, existing occupational health standards, and a correlation of exposure and effect. In addition, methods for worker protection are discussed, including suggested work practices, engineering controls, personal protective clothing and equipment, and exposure monitoring and recordkeeping.

3 PROPERTIES, PRODUCTION, AND POTENTIAL FOR EXPOSURE

3.1 CHEMICAL AND PHYSICAL PROPERTIES

EGBE and EGBEA are part of a family of ethylene glycol monoalkyl ethers represented by the general formula $R_1OCH_2CH_2OR_2$, where R_1 represents the alkyl (butyl) moiety and R_2 either H or acetate.

EGBE is also known as butyl Cellosolve[®], 2-butoxyethanol (2-BE), Dowanol EB[®], Jeffersol EB[®], Ektasolve EB[®], or butyl Oxitol[®]. The chemical formula for this organic compound is $C_4H_9OCH_2CH_2OH$. EGBE is a colorless liquid with a mild ether odor; the odor threshold is 0.10 ppm [Amoore and Hautala 1983]. This compound is miscible in water and is soluble in most organic solvents.

EGBEA, the acetate ester of EGBE, is also known as butyl Cellosolve[®] acetate, 2-butoxyethyl acetate (2-BEA), Ektasolve EB[®] acetate, or butyl glycol acetate. This organic compound has the chemical formula $C_4H_9OCH_2CH_2OCOCH_3$. EGBEA is a colorless liquid with a fruity odor [Sax and Lewis 1987]. The compound is only slightly soluble in water, but it is soluble in hydrocarbons and organic solvents. Other chemical and physical properties are listed in Table 3-1.

3.2 PRODUCTION METHODS AND USES

EGBE is usually produced by a reaction of ethylene oxide with butyl alcohol, but it may also be made by the direct alkylation of ethylene glycol with an agent such as dibutyl sulfate [Rowe and Wolf 1982]. Temperature, pressure, reactant molar ratios, and catalysts are selected to give the product mix desired. Ethylene glycol monoalkyl ethers are not formed as pure compounds but must be separated from the diethers of diethylene glycol, triethylene glycol, and the higher glycols. EGBEA is prepared by esterifying EGBE with acetic acid, acetic acid anhydride, or acetic acid chloride.

EGBE is widely used as a solvent in surface coatings such as spray lacquers, quick-dry lacquers, enamels, varnishes, varnish removers, and latex paint [Leaf 1985; Sax and Lewis 1987]. In surface coatings, it imparts blush resistance, gloss, and good flow-out [Carpenter et al. 1956]. EGBE is also used as a coupling agent in metal cleaning formulas and household cleaners, as an intermediate in EGBEA production, and as a component in herbicides and automotive brake fluids [Leaf 1985]. Table 3-2 presents production figures for EGBE and EGBEA.

Table 3-1.—Chemical and physical properties of EGBE and EGBEA*

Property	EGBE	EGBEA
RTECS [†] accession number	KJ8575000	KJ8925000
CAS [‡] registry number	111-76-2	112-07-2
Molecular formula	C ₆ H ₁₄ O ₂	C ₈ H ₁₆ O ₃
Molecular weight	118.2	160.2
Specific gravity at 25°/4°C	0.898	0.940
Evaporation rate (butyl acetate = 1.00)	0.1	0.03
Boiling point (°C)	170.8	192.2
Freezing point (°C)	-77	-63.5
Vapor pressure (mm Hg at 25°C)	0.88	<0.98
Refractive index	1.417	1.414
Flash point (°C), closed cup	62	71
Autoignition temperature (°C)	238	340
Flammability limits (vol. % in air)	1.10-12.7	0.88-8.54
Water solubility (% by weight)	Miscible	1.5
Vapor density (air = 1)	4.1	5.5
ppm in saturated air (25°C)	1,200	<1,300
mg/m ³ at 25°C, 760 mm Hg**	4.83	6.55
ppm at 25°C, 760 mm Hg ^{††}	0.21	0.15

* Adapted from Rowe and Wolf [1982], UCC [1985], and NFPA [1987].

[†]Registry of Toxic Effects of Chemical Substances [NIOSH 1987c].

[‡]Chemical Abstracts Service.

** Equals 1 ppm.

^{††} Equals 1 mg/m³.

Table 3-2.—U.S. production of EGBE and EGBEA*

Compound	Production (lb)	Latest year data was available
EGBE	302,979,000	1986
EGBEA	11,000,000	1977

*Source: TSCAPP [1977] and USITC [1986].

EGBEA is primarily used as a retarder solvent* for nitrocellulose lacquer and epoxy and acrylic enamels; it is also a film-coalescing aid for polyvinyl acetate latex, and it may be used in some ink and spot remover formulations [Leaf 1985; Sax and Lewis 1987].

3.3 NUMBER OF WORKERS POTENTIALLY EXPOSED

The National Occupational Exposure Survey (NOES) [NIOSH 1983] estimates that during the period 1981-83, 1,680,768 workers were occupationally exposed to EGBE and 123,911 workers were occupationally exposed to EGBEA. Among industries labeled by the four-digit Standard Industrial Code (SIC), 375 were identified as having workers potentially exposed to EGBE, and 104 were identified as having workers potentially exposed to EGBEA. NOES identified 222 occupations as having workers potentially exposed to EGBE, and 62 occupations as having workers potentially exposed to EGBEA. Table 3-3 presents the six industries and the six occupations with the most workers potentially exposed to EGBE and EGBEA.

Table 3-4 presents representative information about the occurrence of airborne EGBE or EGBEA in the workplace. The limited data collected at facilities in the United States indicate that most exposures to EGBE or EGBEA are below 7 ppm. The highest exposures for EGBE and EGBEA occurred at separate silk-screening facilities (see Table 3-4). In contrast to these data, EGBE exposures in a Belgian study of various industrial operations [Veulemans et al. 1987b] ranged from 0.04 to 367.2 ppm, and exposures to EGBEA ranged from 0.70 to 4.04 ppm (see Table 3-5).

*Retarder solvents are active, slow-evaporating solvents that ensure smooth film-forming and are generally used in concentrations of 1% to 5% in coating formulations.

Table 3-3.—Six industries and six occupations with the most workers potentially exposed to EGBE and EGBEA *

Compound and industry	Workers exposed		Compound and occupation	Workers exposed	
	Number	% of total		Number	% of total
EGBE: [†]			EGBE: [†]		
General medical and surgical hospitals	191,619	11.4	Janitors and cleaners	344,743	20.5
Building maintenance services	166,790	9.9	Printing machine operators	88,017	5.2
Commercial printing, lithographic	57,127	3.4	Machine operators, not specified	81,594	4.9
Gasoline service stations	35,126	2.1	Miscellaneous machine operators	56,698	3.4
Certificated air transportation	31,713	1.9	Painting and paint spraying machine operators	52,252	3.1
Electric services	31,457	1.87	Automobile mechanics	51,925	3.08
EGBEA: [§]			EGBEA: [§]		
Wood household furniture	14,864	12.0	Assemblers	17,558	14.2
Oil and gas field services	12,988	10.5	Painting and paint spraying machine operators	13,920	11.2
Heavy construction	5,341	4.3	Janitors and cleaners	12,529	10.1
Commercial printing, letterpress	5,147	4.2	Mining machine operators	8,072	6.5
Women's and misses' outerwear	4,442	3.6	Printing machine operators	6,054	4.9
Motor vehicles and car bodies	4,376	3.5	Secretaries	5,306	4.3

*Taken from NIOSH [1983].

[†]Total workers exposed to EGBE = 1,680,768.

[§]Total workers exposed to EGBEA = 123,911.

Table 3-4.—Occupational exposures to EGBE and EGBEA by work site or process

Glycol ether	Work site or process	Reference	Number and type of samples	Concentration (ppm)	
				Range	Average
EGBE	Silk-screening	Boiano [1983]	6 BZ [*]	1.1-5.4	3.5
	Silk screeners	Baker et al. [1985]	16 BZ	†	6.8
	Spray painters	Baker et al [1985]	5 BZ	†	2.6
	Hospital housekeeping	Apol and Cone [1983]	4 BZ	ND [§]	ND
	Coating process	Bryant [1978]	4 area	ND	ND
	Printing	Apol [1981]	7 BZ	1-2	1.8
		Lewis and Thoburn [1981]	3 BZ	<0.04-0.5%	0.18
	Scrubbing of floor	Apol and Johnson [1979]	1 BZ	1.6	1.6
	Manufacture of electrical resistors	Gilles and Philblin [1976]	2 BZ	ND	ND
			2 area	ND	ND
EGBEA	Silk screening	Boiano et al. [1983]	6 BZ	0.8-3.9	2.5
	Printing	Salisbury [1983]	4 BZ	ND-0.8	0.3
			4 area	ND-0.5	0.2

*Breathing zone.

†Data not presented.

§None detected.

Table 3-5.—Concentration of EGBE and EGBEA measured in various industrial operations*
(ppm)

Operation	EGBE		EGBEA	
	Geometric mean	Range	Geometric mean	Range
Printing	0.85	0.31-3.7	1.94	0.70-4.04
Painting	3.9	0.71-19.5	---	---
Car repair	1.23	---	---	---
Miscellaneous	1.77	0.04-367.2 [†]	1.62	1.36-1.8

*Table adapted from Veulemans et al. [1987b].

[†]Concentration recorded in a mirror-manufacturing plant.